NASA Facts

National Aeronautics and
Space Administration

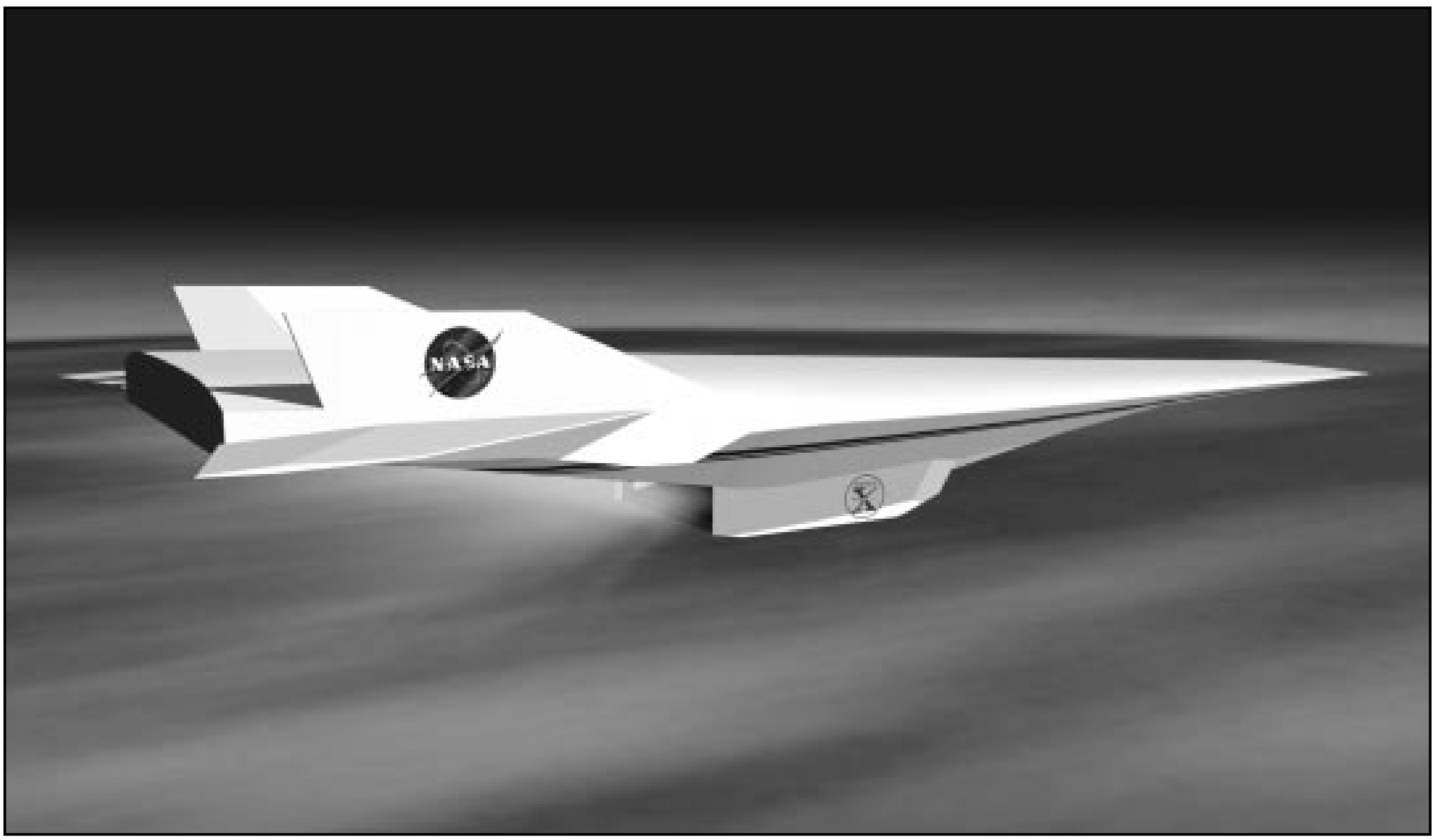
Langley Research Center

Hampton, Virginia 23681-0001
Office of Public Affairs

FS-1998-07-26-LaRC July 1998

NASA “Hyper-X” Program Established

Flights Will Demonstrate Scramjet Technologies



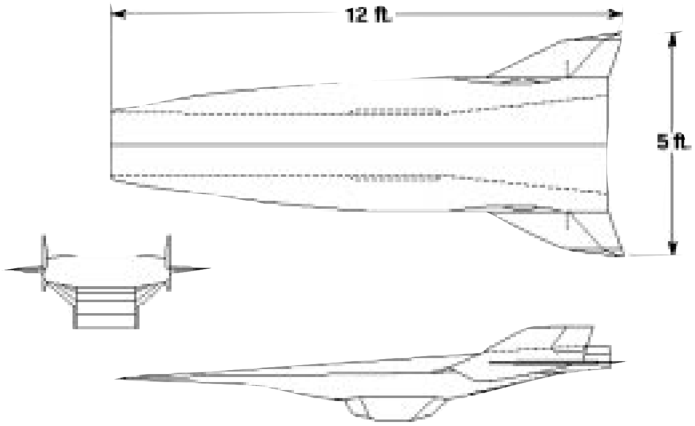
In Phase I of the Hyper-X program, three 12-foot-long, unpiloted aircraft will fly up to ten times the speed of sound to demonstrate “air-breathing” engine technologies. Each high-flying experimental aircraft will fly once, all within the Western Test Range off the coast of California.

NASA has established a multi-year experimental hypersonic ground and flight test program called Hyper-X. The program seeks to demonstrate “air-breathing” engine technologies that promise to increase payload capacity or reduce vehicle size for the same payload for future hypersonic aircraft and/or reusable space launch vehicles.

Payload capacity will be increased by discarding the heavy oxygen tanks that rockets must carry and by using a propulsion system that uses the oxygen in the atmosphere as the vehicle flies at many times the speed of sound. Hydrogen will fuel the program’s research vehicles, but it requires oxygen from the atmosphere to burn.

Langley & Dryden — A Joint Effort

The Hyper-X Phase I is a NASA Aeronautics and



Hyper-X vehicle configuration.

Space Transportation Technology Enterprise program being conducted jointly by the Langley Research Center, Hampton, Va., and the Dryden Flight Research Center, Edwards, Calif. Langley is the lead center and is responsible for hypersonic technology development. Dryden is responsible for flight research.

Phase I is a five-year, approximately $170 million program to flight validate scramjet propulsion, hypersonic aerodynamics and design methods. As envisioned, Phase II would make use of the data, technologies and design methods derived from Phase I to design and build a larger, reusable hypersonic X-plane.

Research Flights From Mach 7-10

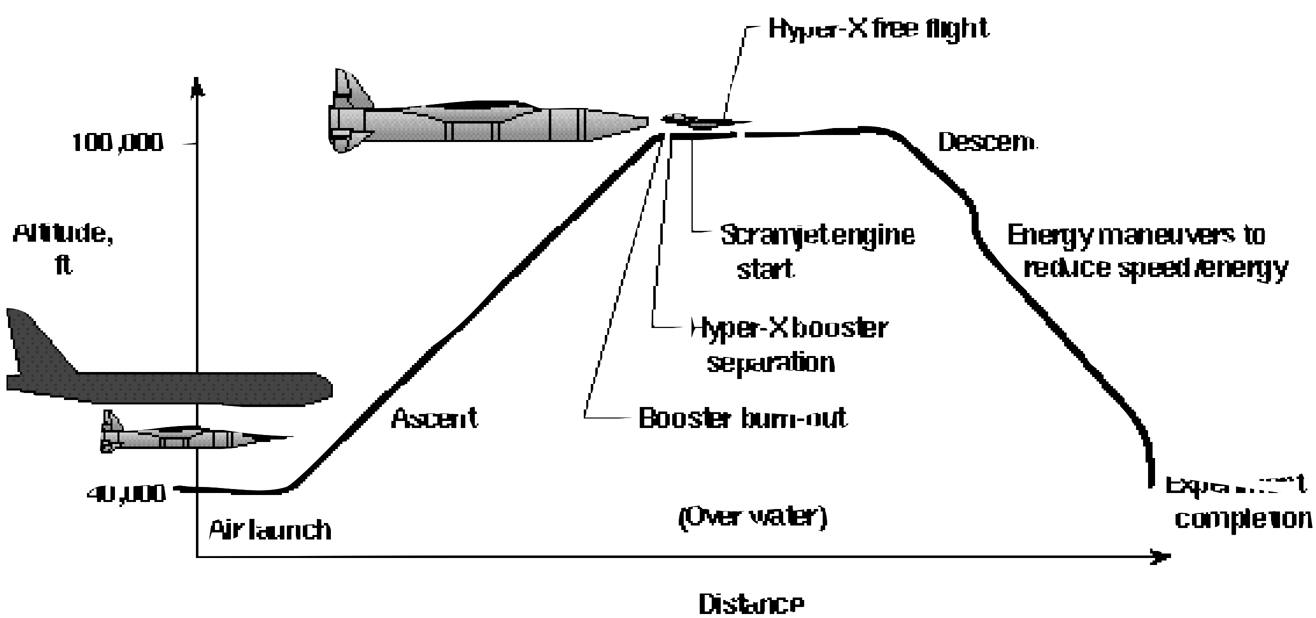
A team led by MicroCraft, Inc. has been selected to fabricate three unpiloted research aircraft in Phase I of the program that NASA will fly at up to 10 times the speed of sound, or approximately 7,200 mph at sea level.

Research began with conceptual design and wind tunnel work in early 1996. The three highly-swept aircraft will be identical in appearance but will be engineered with slight differences simulating engine inlet variable geometry which is generally a function of Mach number. Each vehicle will fly once, at one-year intervals, beginning in early 2000. The first and second flights will be at Mach 7, and the third at Mach 10.

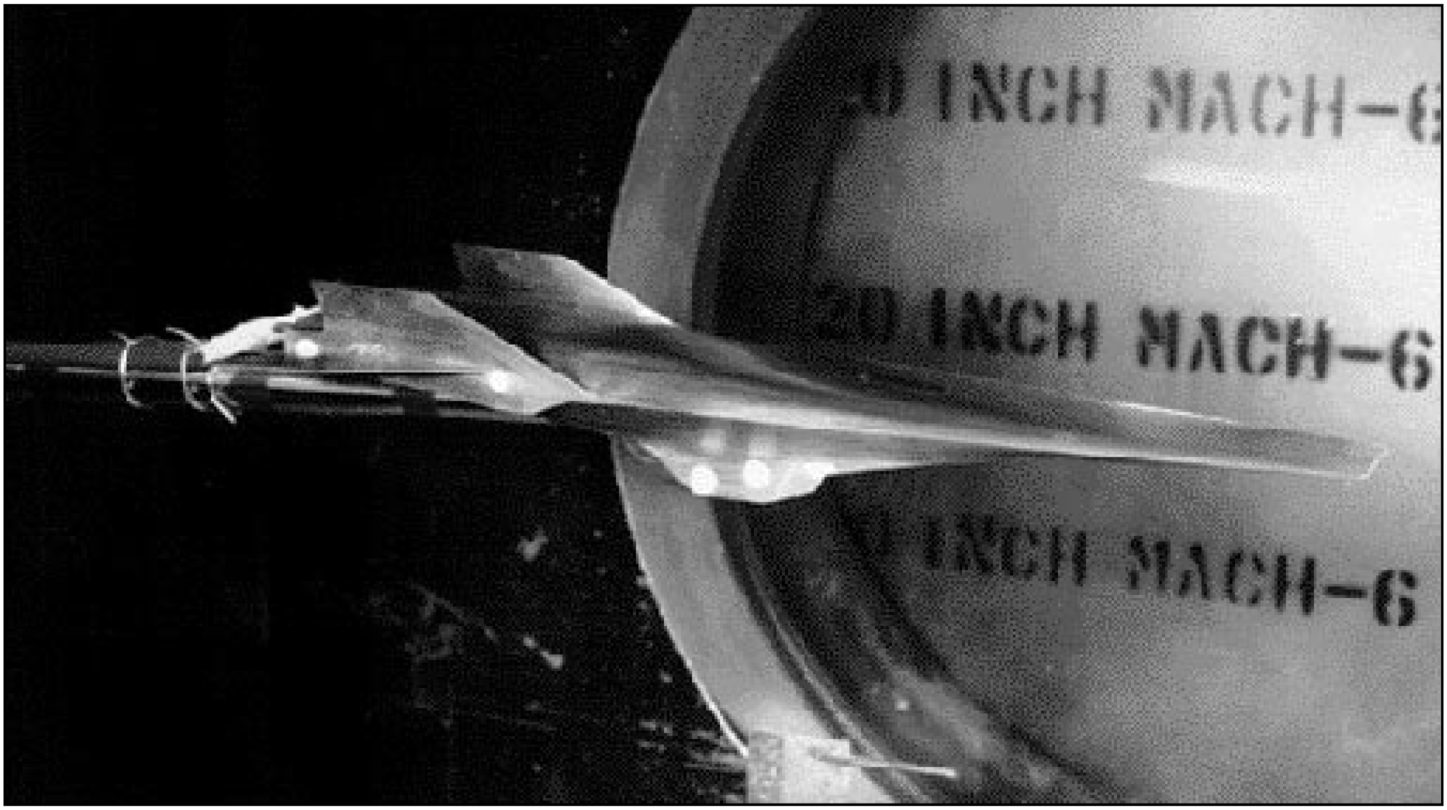
At Mach 10 – or 10 times the speed of sound– the 12-foot-long, 5-foot-wide aircraft will be traveling at about two miles per second (approximately 7,200 miles per hour at sea level). Speeds over Mach 5 are defined as “hypersonic.”

Hyper-X will ride on a booster rocket built by the Orbital Sciences Corp., which will be launched by the Dryden B-52 from an altitude of 19,000 to 43,000 feet, depending upon the mission. For each flight, the booster will accelerate the Hyper-X research vehicle to the test conditions (Mach 7 or 10) at approximately 100,000 feet, where it will separate from the booster and fly under its own power and preprogrammed control.

The Hyper-X research vehicle will be separated from the booster rocket by two small pistons. Shortly after separation, the Hyper-X scramjet engine will operate for seven-plus seconds to demonstrate forward thrust in flight. When the scramjet engine test is complete, the vehicle will go into a high-speed glide to collect up to six minutes of hypersonic aero-



Each of the Hyper-X research vehicles will achieve test speed and altitude with the help of the NASA Dryden B-52 aircraft and an expendable booster rocket, as shown in this simplified flight trajectory.



Wind tunnel tests show good aerodynamic and propulsion performance for the Hyper-X configuration. NASA has logged more than 1,000 wind tunnel tests of the configuration.

dynamic data while flying to a mission completion point. The flight tests will be conducted within the Western Test Range off the coast of California.

Vehicle and engine ground tests and analyses will be performed prior to each flight in order to compare flight and ground test results. Before the first flight, a spare flight engine will be mounted on a wind tunnel model that accurately represents the size and shape of the full-scale vehicle. The model will be tested in Langley's 8-Foot High Temperature Wind Tunnel to simulate a fully operating ramjet/scramjet propulsion system at Mach 7 flight conditions.

First Scramjet Demo Top Goal

This challenging ground and flight research program will significantly expand the boundaries of air-breathing flight by being the first to fly a "scramjet" powered aircraft at hypersonic speeds.

Demonstrating the airframe-integrated ramjet/scramjet engine tops the list of program technology goals, followed by development of hypersonic aerodynamics and validation of design tools and methods for air-breathing hypersonic vehicles.

A ramjet operates by subsonic combustion of fuel in a stream of air compressed by the forward speed of the aircraft itself, as opposed to a normal jet engine, in which the compressor section (the fan blades) compresses the air. Ramjets operate from about Mach 2 to Mach 5.

A scramjet (supersonic-combustion ramjet) is a ramjet engine in which the airflow through the whole engine remains supersonic. Scramjet technology is challenging because only limited testing can be performed in ground facilities. Hyper-X will build knowledge, confidence and a technology bridge to very high Mach number flight.

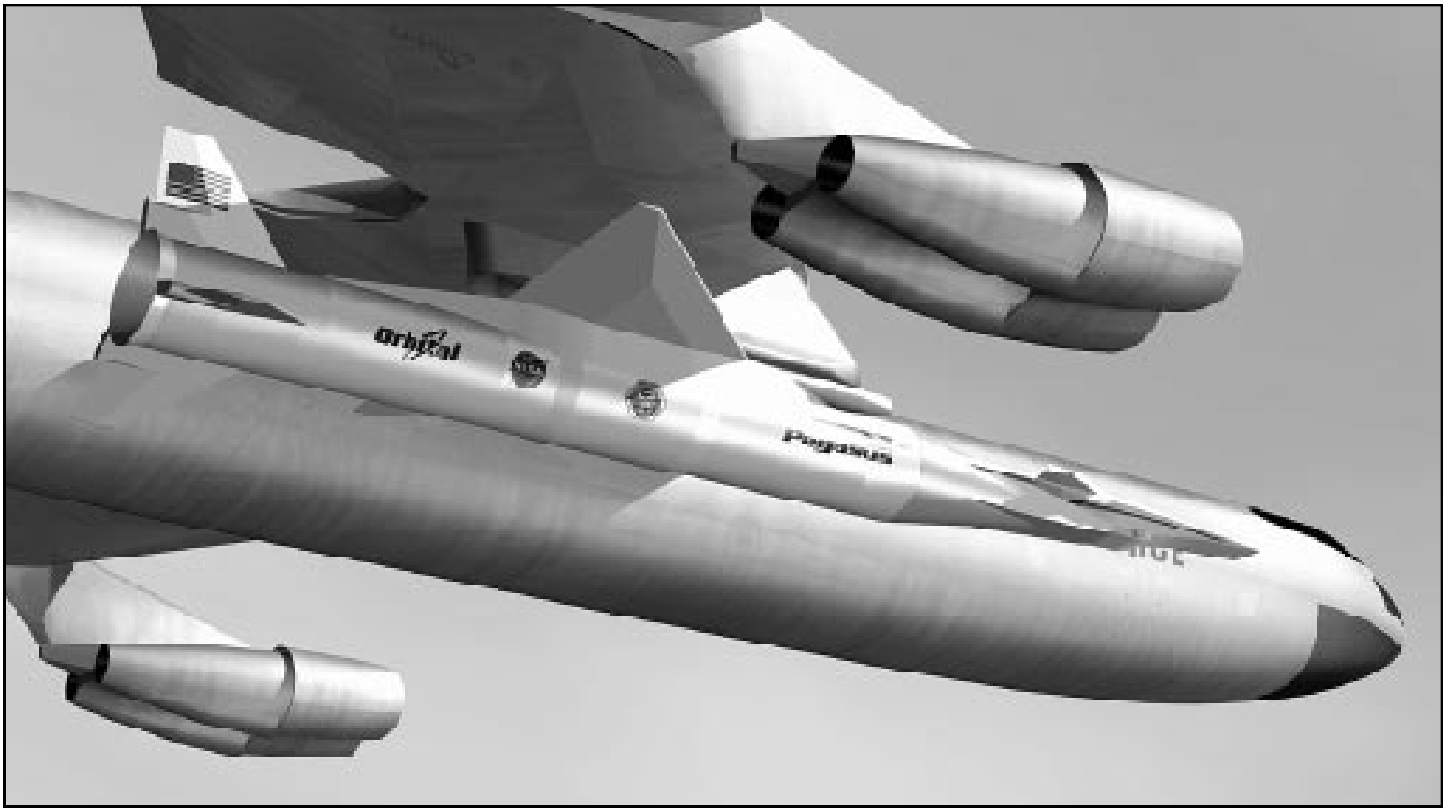
Currently, the world's fastest air-breathing aircraft, the SR-71, cruises slightly above Mach 3. The highest speed attained by NASA's rocket-powered X-15 was Mach 6.7. The Hyper-X aircraft will fly faster than any previous air-breathing aircraft.

Glossary of Terms

aerothermal performance. Aerodynamic performance when velocities are high enough for aerodynamic heating to become important.

air-breathing. An aircraft propulsion system which sustains combustion of fuel with atmospheric oxygen.

airframe. Assembled structure of aircraft, together with system components forming integral



The Hyper-X program will make use of proven systems to deliver the research vehicles to test altitude and velocity.

part of structure and influencing strength, integrity or shape.

airframe-engine integration. The structural and aerodynamic mating of an aircraft's airframe with its engine or propulsion system. In the case of hypersonic scramjet propulsion system concepts, the engine is typically mounted flush to the underside of the airframe in a highly-integrated fashion. The underside of the airframe's forebody is shaped to help prepare the flow of air into the engine inlet, while the underside of the airframe's aft section is shaped for optimum exhaust flow.

highly-swept. A swept wing is one in which the leading edge has an obvious backwards inclination from the root (where wing meets fuselage) to wing tip.

hypersonic. Operation at Mach number exceeding 5.

Mach number, M. Ratio of true airspeed to speed of sound in surrounding fluid (which varies as square root of absolute temperature). Mach 1 equals the speed of sound, which is 340.294 meters per second or 761.59 mph at sea level (using the 1962 U.S. Standard Atmosphere).

propulsion system. Sum of all components which are required to propel vehicle, eg. engine, accessories and engine-control system, fuel system, inlet and cooling systems.

ram compression. See ramjet.

ramjet. Air-breathing jet engine similar to a turbojet but without mechanical compressor or turbine; compression is accomplished entirely by ram and is thus sensitive to vehicle forward speed and non-existent at rest.

scramjet. Supersonic combustion ramjet; one in which the flow through the combustor itself is still supersonic.

speed of sound. See Mach number.

trajectory. Flight path in 3-D of any object, eg. aeroplane or electron or other particle, with exception of orbits and other closed paths. Can be ballistic, acted on only by atmospheric drag and gravity, or controlled by various external forces.

vehicle configuration. Gross spatial arrangement of major elements, i.e., disposition of wings, bodies, engines and control surfaces.

wind tunnel. A tunnel-like structure through which air is forced at known and controllable velocities to determine the effects of wind pressure on objects held stationary in the airstream.

For more information contact:

NASA Langley Research Center
Office of Public Affairs
Mail Stop 115
Hampton, VA 23681
(757) 864-6124

or

NASA Dryden Flight Research Center
Office of Public Affairs
P.O. Box 273
Edwards, CA 93523
(805) 258-3449